CZES Coastal Zone and Estuarine Studies

FINAL REPORT

EVALUATION OF THE FINGERLING BYPASS SYSTEM OUTFALLS AT McNARY AND JOHN DAY DAMS

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INTRODUCTION

The location of fingerling bypass system outfalls in the tailrace areas below dams has a significant effect on the survival of juvenile salmonids. Discharging fingerlings into areas of predator concentrations could result in greater mortality than passing fingerlings through turbines.

If we are to optimize juvenile salmonid passage at the dams on the Snake and Columbia Rivers, an assessment of fingerling mortality associated with existing bypass system outfalls is essential. Research directed at this problem was initiated in 1976; "O" -age chinook salmon were used to define mortality associated with both the north and south bypass outfalls at McNary Dam. Results of the 1976 tests indicated that survival of test fish released into the north outfall at McNary Dam was significantly higher than for fish released into the south outfall.[1/] In addition, survival at the north outfall was greater during the day than at night (Sims and Johnsen, 1977). Research was continued in 1977. Releases of yearling chinook salmon and steelhead trout were used to define mortality associated with the north outfall at McNary Dam, and with the single outfall at John Day Dam.

METHODS

Juvenile salmonid mortalities associated with the existing bypass system outfalls at McNary and John Day Dams were evaluated in 1977.

1/ The south outfall at McNary Dam is not normally used and was activated only for the purpose of this study.

These evaluations were based on comparative recoveries from test and control releases of marked yearling chinook salmon and steelhead trout. Marked fish were recovered by dipnetting turbine intake gatewells at John Day and The Dalles Dams.

All test and control fish were obtained by dipping gatewells at McNary, John Day, or The Dalles Dams. These fish were marked by freeze branding and released at the locations indicated:

McNary Dam

Test Releases	North bypass outfall,tailrace deck, (11 May to 29 June)
Control Releases	Turbine frontroll (11 May to 1 June)
	Umatilla Bridge (2 June to 1 July)

John Day Dam

Test Releases	Bypass outfall, tailrace deck (11 May to 16 June)
Control Releases	Turbine frontroll (16 May to 17 June)

Control releases at McNary Dam from 11 May to 1 June 1977, were made into the turbine frontroll through a 200-foot hose held in position by a large sea anchor. This release system failed on 2 June and all subsequent control releases were made from a tank truck below the Umatilla Bridge (about 1 mile downstream from the dam). Control releases at John Day Dam were made through a pipe that discharged fish into the turbine frontroll about 100 feet downstream from Turbine Unit Number 1. Test releases at McNary and John Day Dams were made directly into the bypass channel above the outfall.

Because of the limited number of marked fish available, we established priorities on the number of factors that we could examine. Both day and night releases of test and control fish were made at McNary Dam (about 50% day and 50% night). However, only daytime releases of test and control fish were made at John Day Dam.

RESULTS

Record low flows in 1977 drastically reduced smolt survival and effected rates of movement (Sims, Bentley, and Johnsen, 1978). Consequently, outfall evaluations at McNary and John Day Dams were affected. The number of fish available for marking was often less than optimum (especially for steelhead trout) and mark recovery rates were less than desired. However, test results are adequate to define potential problem areas.

McNARY DAM

During the spring of 1977, seven test and seven control groups of marked fish (28,880 spring chinook salmon and 3,250 steelhead trout) were released below McNary Dam to evaluate fingerling mortality associated with the north fingerling bypass outfall. Release and recovery information are summarized and presented in Table 1.

An assessment of day vs. night survival was not possible because the number of fish marked and released was too small. However, day-night release and recovery data have been combined to provide usable survival information relative to the average day-night condition. The recovery rate for yearling chinook salmon test and control releases

Table 1.--Results of fingerling bypass system outfall evaluation at McNary Dam, 1977.

Condition	Release Data Chinook			Recoveries at John Day Dam Chinook			
Condition	Chinook	Steelhead	Period	Chinook	Stld.	Chinook	Stld.
	(No.)	(No.)		(No.)	(No.)	(%)	(%)
Test							
1	4,977	341	11 to 18 May	41	2	0.82	0.59
2	925	54	21 May	9	0	0.97	0.00
3	4,622	205	23 to 27 May	23	0	0.50	0.00
4	1,497	396	31 May to 4 June	12	3	0.80	0.76
5	777	329	6 to 9 June	5	2	0.64	0.61
6	376	224	13 to 16 June	1	0	0.27	0.00
7	1,269	200	24 to 29 June	6	0	0.47	0.00
Totals	14,443	1,749		97	7	$\bar{x}$ = 0.64	0.28
Control							
1	1,689	115	11 to 17 May	28	1	1.66	0.87
2	3,730	235	19 to 21 May	30	0	0.80	0.00
3	4,556	193	23 to 27 May	26	0	0.57	0.00
4	1,941	174	1 to 4 June	19	2	0.98	1.15
5	611	363	8 to 10 June	4	2	0.65	0.55
6	400	215	20 to 22 June	0	0	0.00	0.00
7	1,510	206	29 June to 1 July	2	0	0.13	0.00
Totals	14,437	1,501		109	5	$\bar{x}$ = 0.68	0.37

average 0.64% and 0.68% respectively. The recovery rates for marked steelhead trout were lower, averaging 0.25% for test releases and 0.37% for control releases. For both yearling chinook salmon and steelhead trout the difference in the recovery rate of test and control fish was not statistically significant (See Appendix A1 and A2).

Test releases of marked fall chinook salmon in the north McNary outfall in 1976 produced similar results (Sims and Johnsen, 1977). The north outfall at McNary Dam appears adequate, and its continued use appears to represent no threat to fingerling survival.

JOHN DAY DAM

Nine test groups (12,649 yearling chinook salmon and 5,605 steelhead trout) and nine control groups (13,228 yearling chinook salmon and 3,242 steelhead trout) were released at John Day Dam during the spring of 1977 to define fingerling mortality associated with the bypass outfall at the project. Test results are summarized and presented in Table 2.

In contrast to the findings at McNary Dam, there appears to be a significant level of fingerling mortality associated with the bypass outfall at John Day Dam. The 0.62% mean recovery rate at The Dalles Dam of test groups of yearling chinook salmon released into the bypass channel above the outfall was significantly lower than the 1.22% recovery rate of control groups released below the dam (See Appendix Table A3). This level of difference between test and control recovery rates indicates a differential mortality rate of about 49%.

The differential steelhead trout mortality was estimated to be 64%, based on mean recovery rates of 1.22% for test releases and 3.42% for controls. The difference in recovery rates for test and control releases is statistically significant (Appendix Table A4).

Table 2.--Results of fingerling bypass system outfall evaluation at John Day Dam, 1977.

Condition	Release Data Chinook	Steelhead	Period	Recoveries at The Dalles Dam Chinook	Stlh.	Chinook	Stld.
	(No.)	(No.)		(No.)	(No.)	(%)	(%)
Test							
1	815	253	11 to 19 May	5	7	0.61	2.77
2	989	381	17 to 21 May	15	7	1.52	1.84
3	1,261	323	24 to 28 May	8	1	0.63	0.31
4	5,173	1,927	23 to 27 May	25	16	0.48	0.83
5	595	374	1 to 4 June	2	2	0.34	0.53
6	966	208	2 June	4	2	0.41	0.96
7	771	300	6 to 9 June	5	7	0.65	2.33
8	1,175	1,669	7 to 10 June	3	10	0.26	0.60
9	904	170	13 to 16 June	6	1	0.66	0.59
Totals	12,649	5,605		73	53	$\bar{x}$ = 0.62	$\bar{x}$ 1.20
Control							
1	2,452	319	16 to 19 May	61	15	2.49	4.70
2	1,688	549	18 to 21 May	18	6	1.07	1.09
3	1,373	411	23 to 27 May	23	15	1.68	3.65
4	2,906	404	25 to 28 June	30	8	1.03	1.98
5	672	304	31 May to 2 June	7	10	1.04	3.29
6	2,300	707	31 May	27	15	1.17	2.12
7	352	224	7 to 8 June	3	13	0.85	5.80
8	733	167	9 to 11 June	10	4	1.36	2.40
9	752	157	14 to 17 June	7	9	0.93	5.73
Totals	13,228	3,242		186	95	$\bar{x}$ = 1.29	$\bar{x}$ =3.42

CONCLUSIONS AND RECOMMENDATIONS

1. McNARY DAM

The north outfall of the fingerling bypass system at McNary Dam appears to be safe and effective. No relocation or alteration of the existing structure appears necessary and none is recommended.

2. JOHN DAY DAM

Test results clearly indicate a significant level of smolt mortality at John Day Dam is associated with the location of the fingerling bypass system outfall. The existing outfall discharges directly into the predator infested, slack-water area adjacent to the empty turbine bays at the north end of the powerhouse. The re-directing of the discharge to a safer area of the turbine frontroll should significantly increase smolt survival. It is recommended that outfall modification at John Day Dam be given high priority, since a safe and effective outfall must be developed before the overall problem of smolt passage at John Day Dam can be addressed.

LITERATURE CITED

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APPENDIX

Method of determining statistical significance of 1977 outfall evaluation test results at John Day and McNary Dams.

Table A1. -- Statistical significance test for releases of marked yearling chinook salmon at McNary Dam, 1977.

Table A2. -- Statistical significance test for releases of marked steelhead trout at McNary Dam, 1977.

Table A3. -- Statistical significance test for releases of marked yearling chinook salmon at John Day Dam, 1977.

Table A4. -- Statistical significance test for release of marked steelhead trout at John Day Dam, 1977.

Table A1.—Statistical significance test for releases of marked yearling chinook salmon at McNary Dam, 1977.

Control Releases	% Recovery	Test Releases	% Recovery
1	1.66	1	0.82
2	0.80	2	0.97
3	0.57	3	0.50
4	0.98	4	0.80
5	0.65	5	0.64
6	0.00	6	0.27
7	0.13	7	0.47

Sample mean ($\bar{X}_1$) = 0.68
Sample variance (S_1^2) = 0.31
Sample standard deviation (S_1) = 0.55
Sample size (N_1) = 7

Sample mean ($\bar{X}_2$) = 0.64
Sample variance (S_2^2) = 0.06
Sample standard deviation (S_2) = 0.24
Sample Size (N_2) = 7

Test to determine if the mean recovery rate for control releases ($\bar{X}_1$) is significantly larger than the mean recovery rate for test releases ($\bar{X}_2$) at the 95% confidence level.

Hypothesis: $\bar{X}_1 \leq \bar{X}_2$ where $\partial = .05$ = probability that $\bar{X}_1 \geq \bar{X}_2$

Statistic: $$t = \frac{\bar{X}_1 - \bar{X}_2}{sp\sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$$ where sp = pooled mean square estimate of population standard deviation or:

$$sp = \sqrt{\frac{(N_1 - 1)S_1^2 + (N_2 - 1)S_2^2}{N_1 + N_2 - 2}}$$

Reject if $t_{(1-\partial)(12df)} \geq 1.78$

$$sp = \sqrt{\frac{6(.31) + 6(.06)}{12}} = 0.43$$

$$t = \frac{.68 - .64}{0.43\sqrt{\frac{1}{7} + \frac{1}{7}}} = 0.17$$

Since t is less than 1.78 we accept the hypothesis and conclude that the mean recovery rate of the control releases is not significantly larger than the mean recovery rate of the test releases at the 95% level of confidence.

Table A2.--Statistical significance test for releases of marked steelhead trout at McNary Dam, 1977.

Control Release	% Recovery	Test Releases	% Recovery
1	0.87	1	0.59
2	0.00	2	0.00
3	0.00	3	0.00
4	1.15	4	0.76
5	0.55	5	0.61
6	0.00	6	0.00
7	0.00	7	0.00

Sample mean ($\bar{X}_1$) = 0.37

Sample variance (S_1^2) = 0.24

Sample standard deviation (S_1) = 0.49

Sample size (N_1) = 7

Sample mean ($\bar{X}_2$) = 0.28

Sample variance (S_2^2) = 0.12

Sample standard deviation (S_2) = 0.35

Sample size (N_2) = 7

Test to determine if the mean recovery rate for control releases ($\bar{X}_1$) is significantly larger than the mean recovery rate for test releases ($\bar{X}_2$) at the 95% confidence level.

Hypothesis: $\bar{X}_2 \leq \bar{X}_2$ where ∂ = .05 = probability that $\bar{X}_1 \geq \bar{X}_2$

Statistic: $t = \dfrac{\bar{X}_1 - \bar{X}_2}{sp\sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$ where sp = pooled mean square estimate of population standard deviation or:

$$sp = \sqrt{\frac{(N_1 - 1)S_1^2 + (N_2 - 1)S_2^2}{N_1 + N_2 - 2}}$$

Reject if $t_{(1-\partial)(12df)} \geq 1.78$

$$sp = \sqrt{\frac{6(.24) + (.12)}{12}} = 0.18$$

$$t = \frac{0.37 - 0.28}{0.18\sqrt{\frac{1}{7} + \frac{1}{7}}} = 0.94$$

Since t is less than 1.78 we accept the hypothesis and conclude that the mean recovery rate for control releases is not significantly larger than the mean recovery rate for test releases at the 95 % confidence level.

Table A3.--Statistical significance test for releases of marked yearling chinook salmon at John Day Dam, 1977.

Control Releases	% Recovery	Test Releases	% Recovery
1	2.49	1	0.61
2	1.07	2	1.52
3	1.68	3	0.63
4	1.03	4	0.48
5	1.04	5	0.34
6	1.17	6	0.41
7	0.85	7	0.65
8	1.36	8	0.26
9	0.93	9	0.66

Sample mean $(\overline{X}_1) = 1.29$ Sample mean $(\overline{X}_2) = 0.62$

Sample variance $(S_1^2) = 0.26$ Sample variance $(S_2^2) = 0.14$

Sample standard deviation $(S_1) = 0.51$ Sample standard deviation $(S_2) = 0.37$

Sample size $(N_1) = 9$ Sample size $(N_2) = 9$

Test to determine if the mean recovery rate for control releases $(\overline{X}_1)$ is significantly larger than the mean recovery rate for test releases $(\overline{X}_2)$ at the 99.5 % confidence level.

Hypothesis: $\overline{X}_1 \leq \overline{X}_2$ where $\partial = .005$ = probability that $\overline{X}_1 \geq \overline{X}_2$

Statistic: $t = \dfrac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$ where sp = pooled mean square estimate of population standard deviation or:

$$sp = \sqrt{\frac{(N_1-1)S_1^2 + (N_2 - 1)S_2^2}{N_1 + N_2 - 2}}$$

Reject if $t_{(1-\partial)(16df)} \geq 2.92$

$$sp = \sqrt{\frac{(8)(.26) + (8)(.14)}{16}} = 0.45$$

$$t = \frac{1.29 - 0.62}{0.45\sqrt{\frac{1}{9} + \frac{1}{9}}} = 3.16$$

Since t is greater than 2.93 we reject the hypothesis and conclude that the mean recovery rate for control releases is significantly larger than the mean recovery rate for test releases at the 99.5 % confidence level.

Table A4.-- Statistical significance test for releases of marked steelhead trout at John Day Dam, 1977.

Control Releases	% Recovery	Test Releases	% Recovery
1	4.70	1	2.77
2	1.09	2	1.84
3	3.65	3	0.31
4	1.98	4	0.83
5	3.29	5	0.53
6	2.12	6	0.96
7	5.80	7	2.33
8	2.40	8	0.60
9	5.73	9	0.59

Sample mean $(\overline{X}_1) = 3.42$ Sample mean $(\overline{X}_2) = 1.20$

Sample variance $(S_1^2) = 2.87$ Sample variance $(S_2^2) = 0.79$

Sample standard deviation $(S_1) = 1.69$ Sample standard deviation $(S_2) = 0.89$

Sample size $(N_1) = 9$ Sample size $(N_2) = 9$

Test to determine if the mean recovery rate for control releases $(\overline{X}_1)$ is significantly larger than the mean recovery rate for test releases $(\overline{X}_2)$ at the 99.5% confidence level.

Hypothesis: $\overline{X}_1 \leq \overline{X}_2$ where $\partial = .005$ = probability that $\overline{X}_1 \geq \overline{X}_2$

Statistic: $t = \dfrac{\overline{X}_1 - \overline{X}_2}{sp\sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$ where sp = pooled mean square estimate of population standard deviation or:

$$sp = \sqrt{\frac{(N_1 - 1)\, S_1^2 + (N_2 - 1) S_2^2}{N_1 + N_2 - 2}}$$

Reject if $t_{(1-\partial)(16df)} \geq 2.92$

$$sp = \sqrt{\frac{(8)(2.87) + (8)(0.79)}{16}} = 1.35$$

$$t = \frac{3.42 - 1.20}{1.35\sqrt{\frac{1}{9} + \frac{1}{9}}} = 3.49$$

Since t is greater than 2.92 we reject the hypothesis and concluded that the mean recovery rate for control releases is significantly larger than the mean recovery rate for test releases at the 99.5% confidence level.